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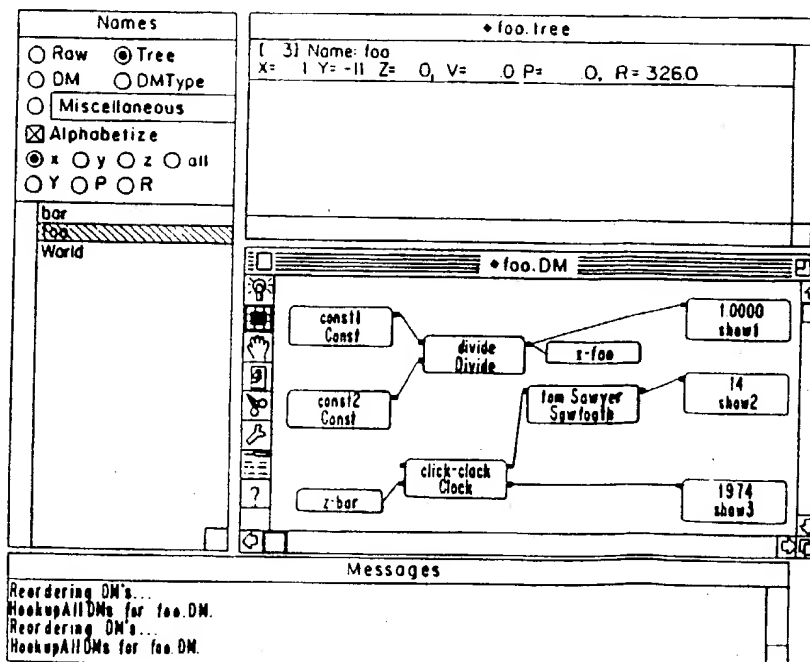
(54) Title: IMPROVED METHOD AND APPARATUS FOR CREATING VIRTUAL WORLDS

(57) Abstract

A computer display displays a data flow network as a plurality of interconnected units. An interactive program allows the appearance of the plurality of interconnected units to be changed. The data flow network then is automatically altered to correspond with the visual changes.

## IMPROVED METHOD AND APPARATUS FOR CREATING VIRTUAL WORLDS

### BACKGROUND OF THE INVENTION

This invention relates to virtual reality systems and, more particularly, to a method and apparatus for creating a virtual world.

Users of computer systems are now able to create virtual realities which they may view and interact with. One type of virtual reality system is disclosed in U.S. patent application No. 535,253, filed June 7, 1990, entitled "Virtual Reality Network," the disclosure of which is incorporated herein by reference. One task which must be performed is the creation of the virtual worlds within which the users interact. This can be a very tedious task, since a complete description of all virtual objects in the virtual world, including their constraints of motion, hierarchy, color, texture and other attributes must be made and entered into the virtual reality computer. Thus, it is desirable to make virtual world creation as simple as possible.

One product used to create virtual worlds is the "Body Electric" program discussed in the above-identified patent application. The Body Electric program allows the user to create virtual world hierarchy trees and to couple data (real world or synthesized) to the tree nodes. Further details of the program maybe found in Appendix 1.

### SUMMARY OF THE INVENTION

The present invention is directed to an improved method and apparatus for creating virtual worlds wherein users may manipulate pictorial objects on a computer screen to effect complicated operations on the virtual world database. In one embodiment of the present invention, a computer display displays a data flow network as a plurality of interconnected units. An interactive program allows the appearance of the plurality of interconnected units to be

changed.   The data flow network then is automatically altered to correspond with the visual changes.

## BRIEF DESCRIPTION OF THE DRAWINGS

5          Fig. 1 is a diagram of a display screen which incorporates features according to the present invention; and

Fig. 2 is a diagram of a display screen which incorporates interprocessor communication features according
10    to the present invention.

## BRIEF DESCRIPTION OF THE APPENDICES

Appendix 1 is a text description of the operation of a program that is used for creating virtual world
15    databases;

Appendix 2 is a listing of numerous examples of virtual worlds created with the present invention;

Appendix 3 is a source code listing of "Body Electric" software which incorporates features of the
20    present invention; and

Appendix 4 is a source code listing of an interprocessor editor according to the present invention.

## DESCRIPTION OF SPECIFIC EMBODIMENTS

25          Fig. 1 is a diagram showing a computer display showing features of the present invention.  It should be referred to in the discussion which follows.

30

35

5

## The Names Window

The introduction of the Names window is one of the most fundamental changes of Body Electric 2.7b3. This window replaces many of the functions that the DM dialog box originally performed.

10

It might be useful to have Body Electric running while reading this. Just start up BE 2.7b3 and open a 'New' file (from the File menu). Body Electric will ask you if you want to create a Tree or DM file. Choose DM.

The "Type" List.

| raw | dm | alpha |
|-----|-----|-------|
| tree | type | |

15

Below is the Names Window with the 'type' box selected. This window is invoked by selecting "Names" from the Window menu.
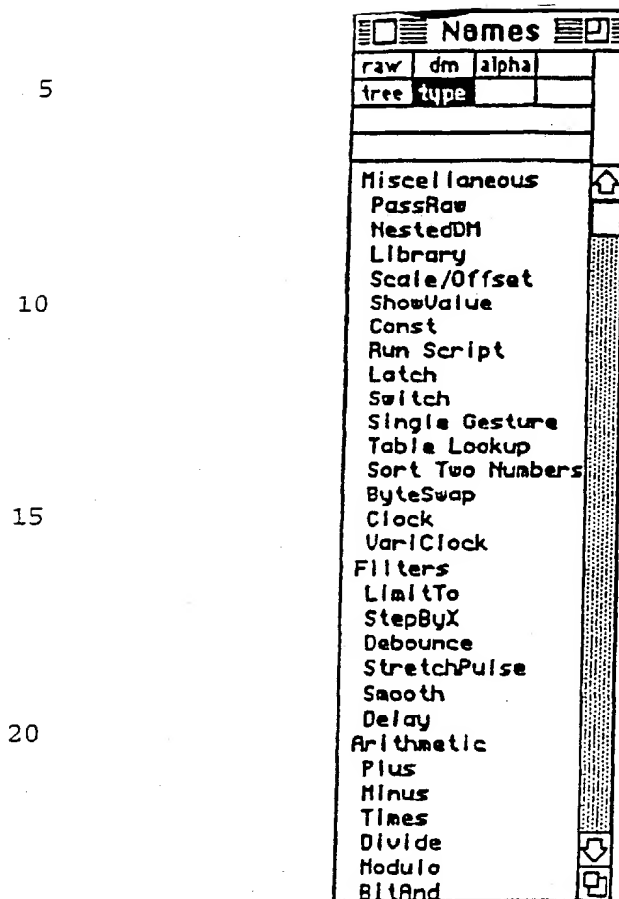
20

25

30

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```
 _____
|▣□▤  Names  ▤▣▤|
|-----------------------------------|
| raw | dm |alpha|       |
|-----------------------------------|
|tree|type|     |       |
|-----------------------------------|
|                                   |
|-----------------------------------|
| Miscellaneous           ⬆        |
|  PassRaw                          |
|  NestedDM                         |
|  Library                          |
|  Scale/Offset                     |
|  ShowValue                        |
|  Const                            |
|  Run Script                       |
|  Latch                            |
|  Switch                           |
|  Single Gesture                   |
|  Table Lookup                     |
|  Sort Two Numbers                 |
|  ByteSwap                         |
|  Clock                            |
|  VariClock                        |
| Filters                           |
|  LimitTo                          |
|  StepByX                          |
|  Debounce                         |
|  StretchPulse                     |
|  Smooth                           |
|  Delay                            |
| Arithmetic                        |
|  Plus                             |
|  Minus                            |
|  Times                            |
|  Divide                  ⬇       |
|  Modulo                           |
|  BitAnd                  ▣        |
 -----------------------------------
```

The names you will see in this list are the DM types that can be used. In order to create a DM of any of these types, simply click on the name of the DM type you desire (without releasing the mouse button) and drag the DM onto a selected DM file window. Note that the DM file window should be selected (and **not** the Names window).

## The "Raw" List

```
 _____
|▓raw▓| dm |alpha|     |
|-----------------------|
|tree|type|    |     |
|-----------------------|
|                       |
 -----------------------
```

A listing of available raw inputs will appear when this box is checked. A raw input can be connected to a DM in a selected DM window by doing

5

basically the same process as was done to drag the DM out. Click down
on the raw input you need and drag it close to the DM input (on the left
side of the DM) that you wish to connect it to. When the raw input is
within connecting distance, the input box it is closest to will light up. By
releasing the mouse button, the raw input should connect itself to the DM.
Another method of connecting a raw input to a DM is to click down on the
DM input and then select the raw input needed. When the mouse button is
released, the connection should be made.

10

### The "Tree" List

| raw | dm | alpha |
|------|-------|------|
| tree | type | |
| x | y | z |
| yaw | pitch | roll |

15

When the tree box is selected, a listing of the tree nodes from the Swivel
file that is activated will appear. The tree file below is from one of VPL's
worlds named "Kitchen". Tree node inputs and outputs can be connected
to DM's in the same fashion as raw inputs are. One thing that is slightly
different is that when using tree nodes as inputs or outputs, the user must

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specify which of the six degrees of freedom is being used. These six degrees of freedom are x, y, z, yaw, pitch, and roll. (see also "The Lower Six Options.")

5

| raw | dm | alpha | |
|---|---|---|---|
| tree | type | | |
| x | y | z | |
| yaw | pitch | roll | |

```
        ClockWall                    ⇧
          ClockFace
          Sound2
          9OClock
          6OClock
          3OClock
          ClockTwelve1
           ClockTwelve2
          SecondHand
          MinuteHand
          HourHand
        Countertop
        CounterBaseboard
        Sink
          HotGrab
            HotGrab_bounds_
              HotGrab_min_
              HotGrab_max_
          ColdGrab
            ColdGrab_bounds_
              ColdGrab_min_
              ColdGrab_max_
        Faucet                        ⇩
        FlowingWater
          Sound4
```

10

15

20

The "alpha" Selection

25

**Names**

| dm | alpha |
|---|---|
| ype | |

When checked, this box makes the selected listing appear in alphabetical order. Sometimes this is advantageous. When looking for a specific DM it can be very useful to be able to find it alphabetically. Other times an alphabetical listing can be confusing. For example, if you were trying to see the tree structure of a world, alpha would prevent you from seeing this structure.

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## The "dm" Listing

| raw | dm | alpha |
|-----|-----|-------|
| tree | type | |
| **1** | 2 | 3 |
| 4 | 5 | 6 |

Highlighting the dm box will show a list of the DM's that are in the active DM file. When you create a DM and name it , it will appear in this menu. With 'dm' comes the numbers 1 through 6 in the lower half of the names menu section (see above).

The dm menu item is useful as a time saver. Instead of searching through your file for a DM, you can find it here and use it as an input or output. Just select the in or out port (1-6) that you wish to use and then use this list like you would use the "raw" and "tree" lists.

## The Lower Six Options

| **X** | y | z |
|-------|-------|------|
| yaw | pitch | roll |

| **1** | 2 | 3 |
|-------|---|---|
| 4 | 5 | 6 |

The six bottom boxes in the Names Window menu are modifiers. Modifiers appear in three cases: with the Tree, Type, and DM lists. These modifiers specify either the degree of freedom or the number of the input depending on the list chosen. For example, when creating a set of DM's that will move an object in VR, Body Electric usually needs to know what axis of the object should move. Do you want the object to move along the x axis, or do you want it to roll? In order to use the correct "axis" of an object, select x, y, z, yaw, pitch, or roll before "grabbing" the desired node. In the same way, choose the number of the input or output you are using.

# The "Flex" Window

Body Electric 2.7b3 now allows the user to have more than one window open at a time. Because of this, the menu items "Flex" and "Tree" from the Windows menu no longer exist. In place of this, Body Electric now lists the names of the files that are open. To open a DM file (what used to be opened by "Flex" in the Windows menu) called *name*, choose *name*.DM. To open a tree file (or the Swivel file), choose *name*.

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## Activate (Windows Menu)

5

> **Windows**
> **Stack Wim**
> **Tile Windo**
> **Close All U**
> **Activate**

10

Body Electric must know which tree and DM file to run at any point in time. Because multiple files may be open simultaneously, the user must alert Body Electric to which set of files are being used. That is, the user must make sure that the files being worked on are "Activated". To do this, open the window to be activated. With this window selected, choose "Activate" from the Windows menu.

In order to check whether a file is activated or not, look in the Windows menu. Files that are active have solid diamonds to the left of their name. Libraries and Nested DM's that belong to activated files have hollow diamonds next to their names.

15

## BE Workbench Tools



20
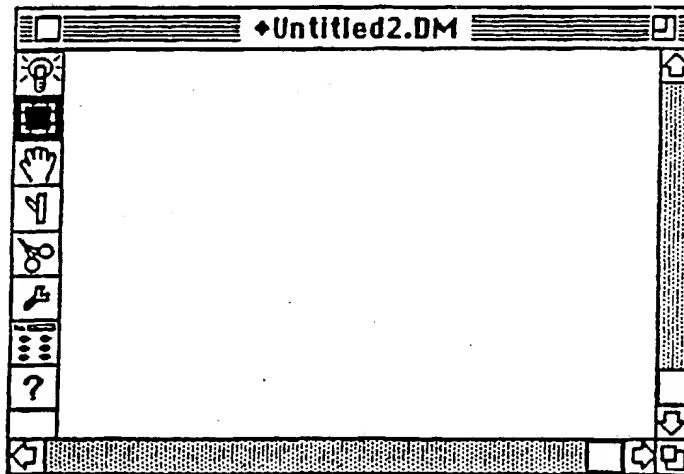
25

30

This is a picture of a new DM window. On the left hand side of the DM window are 6 tools. From top to bottom they are named the Select tool, the Hand tool, the On/Off Switch tool, the Calibrate tool (it's a wrench), the Input/Output tool, and the DM description tool.

35

The Select tool is the default tool for DM windows. It operates in the same fashion as the standard Macintosh arrow. To select a single box, click on it. To select several DM's in the same area, pull a box out around the desired boxes. To select more than one DM one by one, hold down the shift button while clicking on the desired DM's.

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With the Hand tool, the user can "grab" the workspace within the DM window and slide it around like a sheet of paper on a desk. This is an alternative to using the scroll bars.

The On/Off Switch tool allows the user to turn DM's on or off very quickly. There are two ways of using this tool. One way is to select the On/Off tool and then click on the DM that needs to be turned on or off. Another way allows the user to turn on or off multiple DM's simultaneously. First select the DM's you want to change (see the Select Tool). Then hold down the mouse button on the On/Off tool until it starts blinking. When you release the mouse button, the selected DM's will either be turned on or off.

The Scissors tool, is used to break connections that already exist between DM's and other DM's, Tree or Raw inputs. To use this tool select it and then click on the input pad you want to disconnect. The input that's going into that tab will be disconnected and the tab will go to it's default if it has a default or if not the DM will be turned off.

The Wrench, or Calibrate tool, is used to set the internal information of a DM. For example, when calibrated, the Scale/Offset DM presents the dialog box below. Not all DM's have calibration boxes (*e.g.*, 3Times, Average Two, Cube)

```
┌─────────────────────────────────────────────────┐
│                                                   │
│  Fixed Scale/Offset DM module 'UPL                │
│  Research'.                                        │
│                                                   │
│  ███████████████████████████████████████████████ │
│                                                   │
│  And the new offset value:                        │
│                                                   │
│  ┌─────────────────────────────────────────────┐ │
│  │ 0.00000                                       │ │
│  └─────────────────────────────────────────────┘ │
│                                                   │
│  ┌──────────┐                      ┌──────────┐  │
│  │   OK     │                      │  Cancel  │  │
│  └──────────┘                      └──────────┘  │
│                                                   │
└─────────────────────────────────────────────────┘
```

The Input/Output Tool lets the user modify the number and type of inputs and outputs for each DM. To use it, select this tool and click on

any DM. Here is what a common Input/Output dialog box looks like (this is from the DM Scale/Offset).

```
┌─────────────────────────────────────────────────┐
│                                                   │
│   Scale/Offset     ☒ DMLines      ☐ Display      │
│                                                   │
│   Name:  ┌─────────────────────┐   ☐ On          │
│          └─────────────────────┘                 │
│                                                   │
│   ┌─────────────────┐      ┌─────────────────┐   │
│   │ undefined       │      │ Integer         │   │
│   └─────────────────┘      └─────────────────┘   │
│   ┌─────────────────┐      ┌─────────────────┐   │
│   └─────────────────┘      └─────────────────┘   │
│   ┌─────────────────┐      ┌─────────────────┐   │
│   └─────────────────┘      └─────────────────┘   │
│   ┌─────────────────┐      ┌─────────────────┐   │
│   └─────────────────┘      └─────────────────┘   │
│   ┌─────────────────┐      ┌─────────────────┐   │
│   └─────────────────┘      └─────────────────┘   │
│   ┌─────────────────┐      ┌─────────────────┐   │
│   └─────────────────┘      └─────────────────┘   │
│   ┌───────────────────────────────────────────┐ │
│   │ outX = inX * const scale + const offset.  │ │
│   │                                           │ │
│   │                                           │ │
│   │                                           │ │
│   │                    ┌──────┐  ┌────────┐   │ │
│   │                    │  OK  │  │ Cancel │   │ │
│   │                    └──────┘  └────────┘   │ │
│   └───────────────────────────────────────────┘ │
└─────────────────────────────────────────────────┘
```

As you can see, this is also the dialog box in which you can name a DM. With the DMLines box checked lines are drawn from the inputs of this DM to the outputs of other DM's. This is the default.

The Display check box

When the On box is checked, the DM is on (*i.e.*, it is being looked at by Body Electric).

The twelve boxes (just below the name box) control how many inputs and the outputs the DM will have, as well as what type each input and output will be. Say for example that you want to have 3 inputs on a Scale/Offset

DM of type Integer. To do this, click down on the third box down in the left most column. The following menu will appear.

```
┌─────────────┐
│ unused      │
│ Integer     │
│ Long        │
│ Fixed       │
│ Real        │
│ Point       │
│ Same        │
│ PointList   │
│ undefined   │
└─────────────┘
```

By selecting "Integer" and releasing the mouse button, the integer inputs will now appear both in the dialog box as well as on the DM itself. The same method can be used to change the type and number of the outputs.

Note that by changing the inputs of a DM, the outputs usually are altered automatically based upon the DM being worked on.

And finally, the bottom-most box contains a description of the DM.

By selecting the DM Description Tool and clicking on a DM, a description of the DM will appear across the top of the window. This box describes what the DM does. It is useful for finding out what a DM does as well as for double-checking what any specific input is used for.

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Another of the fundamental changes in Body Electric is the addition of Libraries and Nested DM's.

5    Nested DM's are DM networks that exists inside other DM networks. When the outer network executes, it calls the Nested DM which executes it's network, and if it in turn has Nested DM's inside it they are called etc. This hierarchical descent occurs to as many levels as necessary. Each Nested DM has one input which determines if the Nested DM will be fired at all and up to 5 other inputs which are passed to the DM network inside the Nested DM. The Nested DM can have up to 6 outputs that are passed

10   from the network to the Nested DM.

The Library DM is a special case of a Nested DM. In this case the DM network exists inside another DM file. This allows you to have functions that are shared amongst different worlds. They can be added to any world by creating a Library DM that refers to the desired library file. This DM

15   was created to allow the user to include common and/or general Data Massage Modules into her or his program without too much grief. This DM has been created in the spirit of standard programming libraries such as the ones in C.

20   # Additional Features

Find Dialog Box; This dialog box has a new checkbox called 'Global Search.' When it is unchecked all searches will be in the Tree or DM window you are currently editing. When it is checked the search will be

25   conducted over all the currently opened files and for DM's all the nested DM's in the files.

Mouse Active; There is a new menu item called Mouse Active under the DA menu. By default this comes up checked. When you uncheck it the mouse and keyboard items in the Raw Data Array become inactive.

30   That way you can use them as inputs to a DM network for testing. When you want to work on the network uncheck Mouse Active and your network won't react to mouse movements as you are editing.

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- Swivel IPC Specifications
  - Brief Description
    - The Swivel IPC (Inter-Process Comunications) has been designed to allow external editors access to Swivel3D worlds while Swivel is running. With it we have the ability to come up with new ways of creating and editing 3D solid objects. Swivel can always draw any object as a list of polygons. But to edit an object Swivel looks at the objects type. If it is a standard swivel lathe object swivel calls it's internal editor but if it is another object type swivel tries to launch the associated editor and passes a message to edit the given object. When you launch Swivel under Multifinder it runs as one application (program). Under MultiFinder there can be a number of applications launched at the same time. When the user tells swivel to edit an object which uses another editor swivel looks up the name of the editor application and tries to launch that. If successful swivel posts a message in the SwivlPC for that editor which tells the editor to edit the object. The editor edits the object and then posts a message back to swivel to check the object back in. Swivel reads the object back in and updates it's database of objects.
    - The way messages are passed is through a resource called 'YPJK', 0 which is in the system file and is accessible to all applications. This resource doesn't normally exist so the first time SwivlPC is used the resource has to be added to the system.
    - Since any application can access the message passing resource we wanted a way to protect our rights to the technology. Swivel will ignore messages from any editor until the editor has "registered". This gets reset each time swivel runs. "Registering" means that the editor has to send a register message with a pointer to the string "Unauthorized use is subject to legal action." Until the editor does this swivel will ignore any messages from the editor.
  - Message passing scenario
    - User double-clicks on a object that is edited by the terrain editor (#67).
    - Swivel tries to find and launch 'Terrain Editor'. Swivel also post a message to number 67 saying edit the object at location $xxxxx.
    - The Terrain Editor starts running and looks in the system resource for messages. It sees that there is a message from swivel to it to edit an object. It sends the registration message back to swivel and brings up a window so the user can edit the object.
    - When the user is done and has clicked OK the terrain editor sends a message back to swivel to check in the object the user has edited.
    - Swivel receives the message and replaces the old copy of the object with the newly edited object.
    - The terrain editor can at this point either quit or hang around waiting for some more messages from swivel.
  - Possible Messages
    - MsCheckIn
      - Check an object into swivel that has been edited by an editor.
      - Data, DataLen - Handle to and length of memory in the editor for the new object.
      - modifiers:
    - MsCheckOut
    - MsEditObj
    - MsGetCrntObj

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- ► MsSetCrntObj
- ► MsDoCommand
- ► MsQuiting
- ► MsStartFast
- ► MsEndFast
- ► MsRegisterEd
► message format
  - ► 'C' structure definition for System Resource 'YPJK',0.
    - ► typedef struct {
      ```
      short   whomto;      /* whom is the message for */
      short   whomfrm;     /* whom is the message from */
      short   status;  /* IPC status.  Sending, received or
      error.  */
      short   messcount;     /* Unique incrementing message
      number  /
      short   what;
      short   modifier; /* Modifier to the what field.  */
      long    when;  /* TickCount when the message was sent, */
      long    Date;  /* Used by Individual messages however they
      want.  /
      long    DataLen;
      } SwivlPC, *SwivlPCPtr, **SwivlPCHandle;
      ```
  - ► whomto is the number of the editor or swivel the message is for.  This is an arbitrary 16 bit number which is unique for each editor.  Swivel is #1.
    - ► The only other unique address is -1.  This is a broadcast to all editors.  Each editor should read the message but not change the status.  That wal all the current editors can see the message.  Broadcast messages will last for 10 seconds.  Then anyone reading the message must set it's status to 0 thereby stopping the message.
  - ► whomfrm is the same as whomto but it's whom the message is from.
  - ► status - The current state of the message passing mechanism. It is either:
    - ► 0 - not being used
    - ► 1 - message has been sent and not received.
    - ► Any other number - The sendee has posted an error.  Using the macintosh error conventions the errors posted should be negative but any number other than 0 or 1 is considered an error.
  - ► messcount - Used to keep track of the number of messages posted.  Each time a message is posted this value is incremented.
  - ► what - The message verb.  See above.
  - ► modifier - meaning dependant on the what field.
  - ► when - When the message was posted in Macintpsh System Ticks.
  - ► Data - meaning dependent on the what field.
  - ► DataLen - meaning dependent on the waht field.

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The purpose of the Swivel PC is to allow the Swivel interface to be customized and extended for specific purposes. Many different editor extensions are possible. The one implemented in the code provided in Appendix 4 is called the

5  Orientation Editor.

The Orientation Editor allows those aspects of the Swivel file used by Body Electric for the RB2 Virtual Reality System to be edited and stored within the Swivel file. These aspects include point attributes like bound, cube, line,

10  LineDown, or Line Right, which determine how the point is rendered in Body Electric, as well as enabling particular degrees of freedom (Roll, Pitch, Yaw, X, Y or Z) to be output serially to another [host] computer. The Orientation Editor also allows the user to send command scripts to Swivel, to

15  check all the names of objects in the Swivel file for uniqueness, to inherit selected attributes, and to mark, and return to world viewpoints. These capabilities enhance the user's ability to create Swivel Models for use in RB2.

TRhe improved Body Electric software described may

20  be used for creating a number of virtual worlds. Examples of such virtual worlds are shown in Appendix 2.

While the above is a complete description of a preferred embodiment of the present invention, various modifications may be employed. Consequently, the scope of the

25  invention should not be limited except as described in the claims.

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WHAT IS CLAIMED IS:

1.   An apparatus for creating virtual worlds comprising:

5        display means for displaying a data flow network as a plurality of interconnected units;

means for altering the appearance of the plurality of interconnected units on the display; and

means for automatically altering the data flow
10   network to correspond to the altered appearance of the plurality of interconnected units.
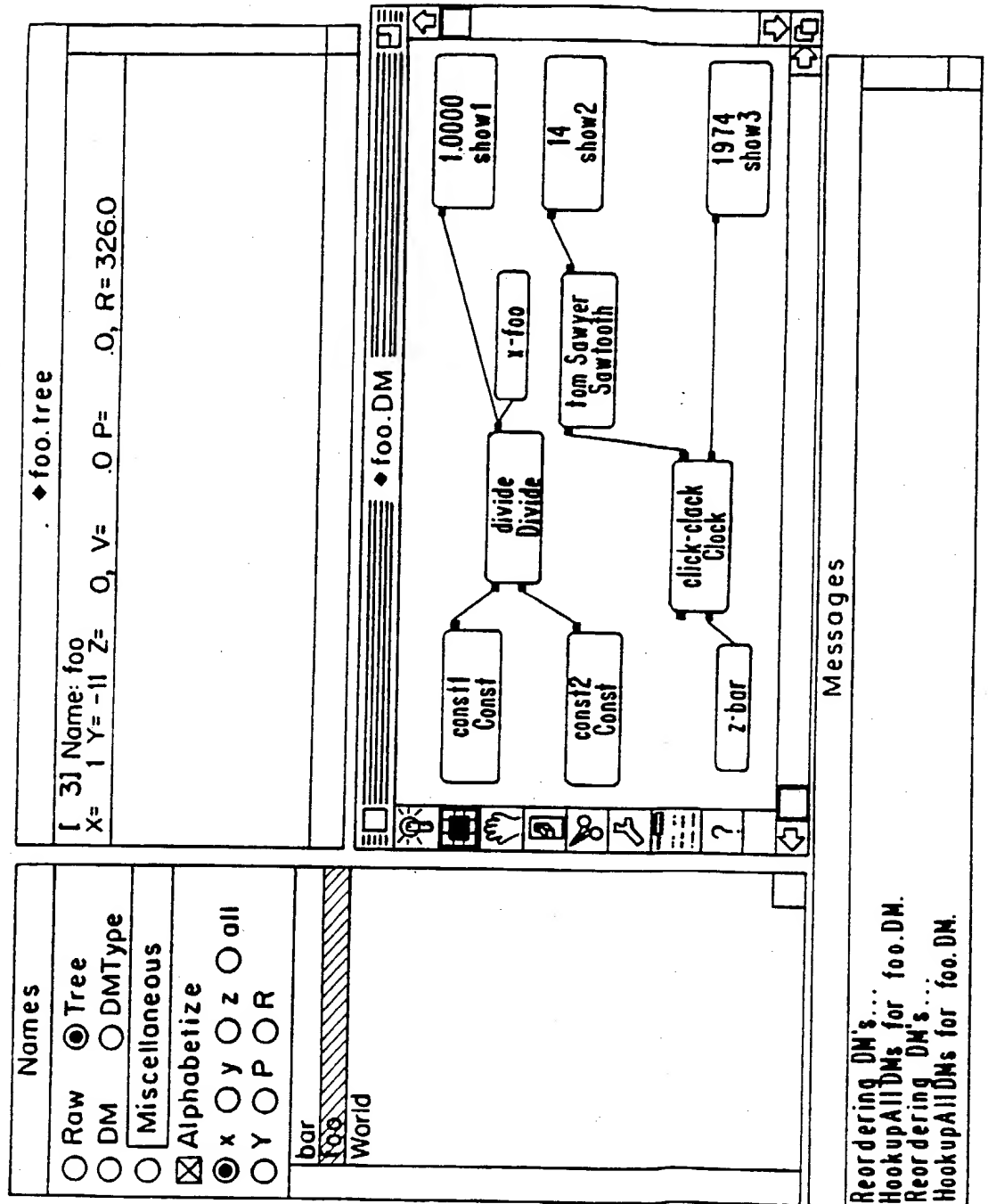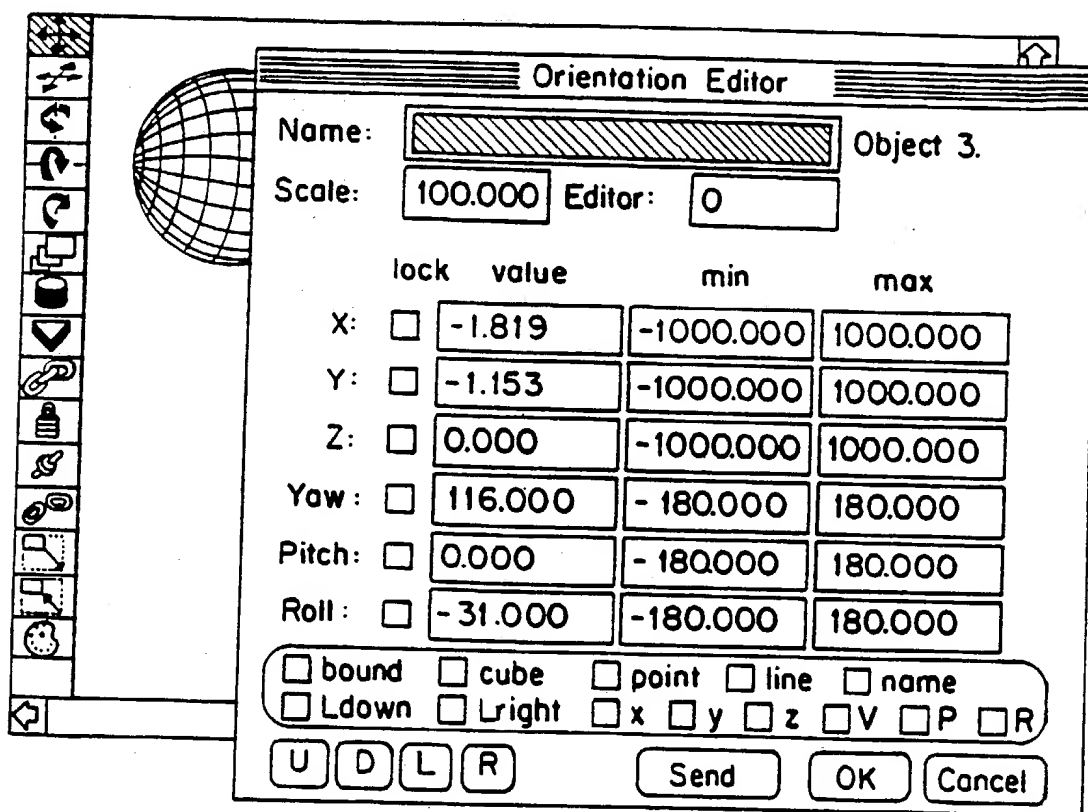
FIG. 1.

## FIG. 2.

**Commands**
- Send Scripts
- Check Names
- Install Into Swivel
- Inherit mode

- Send Register String
- Clear Hung IPC

**Mark**
- Add Marker
- Delete Marker

- Zero World
- 50%
- Puma View
- 50% frm Top
- yaww33

**Windows**
- Messages
- Status
- Orientation Editor

**Orientation Editor**

Name: _____    Object 3.

Scale: 100.000   Editor: 0

| | lock | value | min | max |
|---|---|---|---|---|
| X: | ☐ | -1.819 | -1000.000 | 1000.000 |
| Y: | ☐ | -1.153 | -1000.000 | 1000.000 |
| Z: | ☐ | 0.000 | -1000.000 | 1000.000 |
| Yaw: | ☐ | 116.000 | -180.000 | 180.000 |
| Pitch: | ☐ | 0.000 | -180.000 | 180.000 |
| Roll: | ☐ | -31.000 | -180.000 | 180.000 |

☐ bound ☐ cube ☐ point ☐ line ☐ name
☐ Ldown ☐ Lright ☐ x ☐ y ☐ z ☐ V ☐ P ☐ R

( U ) ( D ) ( L ) ( R )    ( Send ) ( OK ) ( Cancel )

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# INTERNATIONAL SEARCH REPORT

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(5): G06F 3/03
US CL : 395/12, 395/922

## II FIELDS SEARCHED

Minimum Documentation Searched 7

| Classification System | Classification Symbols |
|---|---|
| U.S. | 395/12,140,157,922 |

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched ⁸

## III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹

| Category * | Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹² | Relevant to Claim No. ¹³ |
|---|---|---|
| X | US, A, 4,914,568 (KODOSKY ET AL.) 03 APRIL 1990. See figs. 57,70 and 76-82. | 1 |
| X | US, A, 4,860,204 (GERDRON ET AL.) 22 AUGUST 1989 See figs. 16-17, 19-20, 28-35, and 45. | 1 |
| X | US, A, 4,831,580 (YAMADA) 16 MAY 1989 See figs. 8, 11 and 19-20. | 1 |
| A | US, A, 4,546,435 (HERBERT ET AL.) 08 OCTOBER 1985 See figs. 4-14. | 1 |
| X | US, A, 4,315,315 (KOSSIAKOFF) 01 FEBRUARY 1982 See figs. 2, 5a-6d and 10. | 1 |
| A | IEEE Computer, Volume 18, no. 8, 1989 August Los Alamitos, California, Melamed et al., 'Visual Simulation: The Performance Analysis Workstation', see pages 87-94. | 1 |

* Special categories of cited documents: ¹⁰

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

## IV. CERTIFICATION

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
|---|---|
| 03 FEBRUARY 1992 | 10 MAR 1992 |

| International Searching Authority | Signature of Authorized Officer |
|---|---|
| ISA/US | RICHARD ELLIS |

| III. DOCUMENTS CONSIDERED TO BE RELEVANT   (CONTINUED FROM THE SECOND SHEET) | | |
|---|---|---|
| Category * | Citation of Document.   with indication, where appropriate, of the relevant passages | Relevant to Claim No |
| A | IEEE Computer, Volume 18, no. 8, 1985 August , Los Alamitos, California, Shu, "FORMAL: A Forms-Oriented, Visual-Directed Application Development System", see pages 38-49. | 1 |
| A | IEEE Computer, Volume 18, no. 8, 1985 August, Los Alamitos, California, Jacob, 'A State Transition Diagram Language for Visual Programming', see pages 51-59. | 1 |
| A | IEEE Computer, Volume 17, no. 11, 1984 November Los Alamitos, California, Glinert et al., 'Piot: An Interactive Graphical Programming Environment', see pages 2-25. | 1 |

**FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET**

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**V ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE** [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers          because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers          , because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

3. ☐ Claim numbers_____, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

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**VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING** [2]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (supplemental sheet (2) (Rev. 11-87)

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